DOCUMENT RESUME

ED 393 873 TM 024 747

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TITLE An Evaluation of the Higher Order Thinking Skills Program with Fourth and Fifth Grade Students.
PUB DATE [95]
NOTE 30p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Compensatory Education; *Computer Assisted Instruction; Curriculum; *Elementary School Students; Grade 4; Grade 5; Intermediate Grades; Program Effectiveness; *Reading Achievement; *Self Concept; Sex Differences; *Thinking Skills
IDENTIFIERS *Education Consolidation Improvement Act Chapter 1; *Higher Order Learning

ABSTRACT

The Higher Order Thinking Skills Program (HOTS) is a computer-based program for teaching thinking skills developed by Stanley Pogrow at the University of Arizona. It is now used in over 800 U.S. schools. This study investigated the effects of the HOTS program versus the traditional Chapter 1 program on fourth and fifth grade students' self-concepts, reading achievement, and higher order thinking skills. Of secondary interest was the examination of gender differences in the HOTS and Chapter 1 programs. Subjects included 113 students in the HOTS group and 72 in the traditional Chapter 1 group. HOTS subjects received 45 minutes of instruction each day using the HOTS curriculum and computer applications. Student self-concept, achievement, and thinking skills were measured before and after the intervention. Findings suggested that the HOTS program was effective in raising student self-concept and some higher order thinking skills in grade 5. The program appeared to be more effective after 2 years of treatment, with females affected more than males. Both HOTS and Chapter 1 raised student achievement scores, but there were no statistically significant differences in achievement between the two groups. Results also suggested that more coordination is needed between the HOTS program and the regular classroom. (Contains 12 tables and 27 references.) (SLD)

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An Evaluation of the Higher Order Thinking Skills Program with Fourth And Fifth Grade Students

ED 393 873

In 1988, it was estimated that 25 million of the nations 64 million children were at risk educationally when one of the following five risk factors was considered: race, poverty, family structure, language background, and mother's education (Mills, Stork & Krug, 1992). It is no longer enough to try to improve on what schools are already doing, we must now change school practices fundamentally in order to help these educationally disadvantaged children (David, 1992).

A large majority of these children who are at risk educationally pass through the largest federal compensatory education program in the United States, Chapter 1. The Chapter 1 program was started 30 years ago and now serves approximately 5 million children annually (Anderson, Hollinger & Conaty, 1992). During its early years Chapter 1 led the way in innovative educational methods, but has since stagnated. The vast majority of Chapter 1 programs have never changed from their instructional strategies of drill and practice on basic skills (Asher, 1987). Today, many theorists, educators and researchers are calling for a change in the Chapter 1 programs (Asher & Flaxman, 1988).

One way of changing instruction for students who are at risk educationally is through the use of computers. Computers hold the promise of being able to transform today's curriculum and instructional strategies instead of simply improving what schools are already doing (David, 1992). Computers are being used to provide active learning, authentic tasks, challenging work, complex problem solving, and higher order thinking skills (Dalbey & Linn, 1985; Dalton & Goodrum, 1991; David, 1992; Kagan, 1988; Pogrow, 1987).

Along with the use of computers to help at-risk students, educators are beginning to discover the benefits of teaching higher order thinking skills. Students can learn the thinking skills that underlie all learning and transfer these skills back to the regular content areas raising their achievement levels. Through teacher modeling, practice, and effective teacher questioning, Chapter 1 students can profit from instruction on thinking skills (Adams, 1989; Bruno & Allen, 1992; de Bono, 1983; Pogrow, 1987, 1988, 1990).

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Higher order thinking skills are thinking processes that require more than simple recall of facts (de Bono, 1983). Thinking skills such as problem solving, decision making, conceptualizing, evaluating, synthesizing, and creative thinking require students to evaluate, plan, and monitor their thinking continuously (Lipman, 1991). It would be impossible to solve problems without evaluating what you know about the situation, planning how to get more information and what strategies to use, monitoring your strategies, and evaluating the results.

The use of computers to enhance thinking skills instruction has proven to be effective (Dalton & Goodrum, 1991; Norton & Resta, 1986; Sinatra, Beaudry, Pizzo & Geisert, 1994). Computers may be the ideal mechanism for teaching higher order thinking skills (Saloman, 1986). Combining computers and thinking skills instruction with educationally at-risk students may help to raise Chapter 1 eligible students' achievement levels up to those of their peers, thus fulfilling the original intent of the Chapter 1 program.

An example of a program that combines teaching higher order thinking and the use of computers is The Higher Order Thinking Skills program (HOTS) developed by Stanley Pogrow at the University of Arizona. There are now over 800 schools with HOTS programs in operation in the United States (Pogrow, 1990). However, there have been no empirical studies with control groups conducted to assess the impact of the HOTS program. Specifically, no studies have been conducted to compare the effects of the HOTS program on Chapter 1 eligible students in the fourth and fifth grades to students in the more traditional Chapter 1 programs. These Chapter 1 programs are dominated by basic skills instruction (U.S. Department of Education, 1993b).

The purpose of the present study was to investigate the effects of the HOTS program versus the traditional Chapter 1 program on fourth and fifth grade students' self-concept, reading achievement, and higher order thinking skills. Of secondary interest was the examination of gender differences in both the Higher Order Thinking Skills program and the Chapter 1 program.

Assumptions

The assumptions of this investigation were:

1. Students selected for this study form a representative sample of Chapter 1 eligible students in the fourth and fifth grades in the selected school district.

2. Higher order thinking skills can be taught and learned.

3. The Self-Description Questionnaire - I (Marsh, 1988) was a reliable and valid instrument for measuring students' self-concepts.

4. The Iowa Test of Basic Skills (ITBS) was a reliable and valid instrument for measuring students' reading achievement.

5. The Ross Test of Higher Cognitive Processes (Ross & Ross, 1976) was a reliable and valid instrument for measuring higher order thinking skills in the areas of abstract relations, sequential synthesis, and analysis of attributes.

6. Test conditions were adequate for each participant.

7. The subjects were motivated to participate.

8. The subjects responded openly and honestly.

9. The obtained data were reliable.

Limitations

The limitations of this investigation were:

1. The small sample size may reduce statistical power.

2. Subjects who met the criteria for inclusion in the study were selected from one school district. The non-random method of selection limited generalization of the results of this study.

3. The investigator was not able to control for the influence of outside experiences among the subject

Overview of Methodology

In order to examine the effects of the HOTS program versus the traditional Chapter 1 program on fourth and fifth grade students' self-concept, achievement, and higher order thinking

skills, a pretest-posttest contrast group design was utilized. The subjects included 175 fourth and fifth grade Chapter 1 eligible students, 113 students in the experimental Higher Order Thinking Skills group and 72 students in the Chapter 1 group.

The Chapter 1 program. Chapter 1 students individually are characterized by free lunch program participation, having low family income and low educational attainment of parents (U. S. Department of Education, 1993a). Racial minorities are also more likely to participate in Chapter 1 as compared to their representation in elementary schools in general (U. S. Department of Education, 1993a). According to state reports, 41 % of all Chapter 1 participants are White, 28 % are Black, and 27 % are Hispanic (Sinclair, & Gutmann, 1993).

Assignment to Chapter 1 is based primarily on a student's standardized achievement scores. Students are ranked by school and grade and the lowest scoring students receive services first. Not all students who are eligible receive services, and students do not have to fit into the above characteristics to qualify.

Various types of services are typically provided through Chapter 1 including remediation for reading, math, and language arts. Chapter 1 classes are 45 minutes per day and include from five to ten students. Seventy-four percent of elementary Chapter 1 programs are pullout arrangements (U.S. Department of Education, 1993a). Observations and interviews of Chapter 1 classrooms, teachers, and students by this researcher indicated that the activities consisted mainly of drill and practice over remedial tasks. This is in line with Chapter 1 services across the country where 84 % of elementary schools reported that basic skills drill and practice was a major focus of Chapter 1 instruction (U.S. Department of Education, 1993a). Some of the tasks involved in fourth and fifth grade Chapter 1 sites included reading and recording the titles of below grade level books, language arts work sheets for below grade level skills, computer drill and practice programs on below grade level skills, and spelling practice with below grade level words. There was some project work involved in the Chapter 1 classes such as book reports or projects on books (again below grade level books), and research reports. However, observation of Chapter 1 classes by

this researcher indicated that 92 % of class time was spent on drill and practice of below grade level skills.

The Higher Order Thinking Skills program. All HOTS programs are of the pullout variety and involve students in 45 minutes of instruction per day. Each HOTS program class contained five to ten students. Each class progresses through three curriculum books used only by the HOTS teacher. Students are assigned to the Higher Order Thinking Skills program by Chapter 1 eligibility. The HOTS program is basically designed to be substituted for other Chapter 1 services.

The researcher conducted observations of HOTS classrooms and interviews with students and teachers in these same classrooms. These observations and interviews indicated that the HOTS teachers were closely following the HOTS curriculum guides. These teaching guides provide teachers with step-by-step procedures for each lesson. The basic HOTS lesson involved a group discussion at the beginning of the class period. This discussion involved the teacher posing questions and probing students for answers. These questions and answers led to the discussion of a concept to be covered that day. This discussion generally lasted about 10 minutes. The students then spent approximately 20 minutes working at the computers on software that was intended to let students further develop the concept. There was an occasional activity that linked what was happening in the regular classroom to the HOTS curriculum. For example, students used their regular classroom spelling list to make crossword puzzles in HOTS. In the fifth grade classes there was more of a focus on writing on the computer than in the fourth grade.

Subjects. The subjects for this study were Chapter 1 eligible students. In the state of Georgia there are approximately 160,000 students. Approximately 55% of these students are male and 45 % female. The racial make up consists of 62 % Black, 36 % White, and 2% Hispanic (Georgia Department of Education, 1994). In the school district used in the present study there are approximately 950 elementary Chapter 1 students. Of those students 81 % are Black, 16% are White, and 2% are Hispanic. Approximately, 55% of these students are male and 45 % female. More specifically, in the fourth and fifth grade in the school district there are 442

students, 52% male and 48% female. These students consist of 85 % Black, 13 % White, and 1 % Hispanic ("Clarke County Board of Education, 1995).

The final sample consisted of 175 students in the fourth and fifth grades from one school district in Northeast Georgia. There were 54 first year HOTS students in fourth grade classrooms and 49 second year HOTS students in fifth grade classrooms. The control group consisted of 35 fourth grade and 37 fifth grade students. The subjects included 149 Blacks, 24 Whites, and 2 Hispanic students. There were 92 female and 83 male students.

Data Collection. Three instruments were used to assess the effectiveness of the treatment programs. Student self-concept was measured by using the Self-Description Questionnaire - I (SDQ1) (Marsh, 1988). The Iowa Test of Basic Skills (ITBS) (Riverside Publishing Company, 1986) was used to measure student reading achievement. The Ross Test of Higher Cognitive Processes (Ross & Ross, 1976) was used to measure student higher order thinking skills.

Scores from the spring 1994 administration of the ITBS were used as a pretest for the 1994-95 school year. The pretests for the SDQ1 and the Ross Test of Higher Cognitive Processes were given at the beginning of the 1994-1995 school year and were administered by this researcher. The posttests for all instruments were administered in the spring of 1995. The ITBS test was administered by the individual Chapter 1 and HOTS teachers as prescribed by Chapter 1 regulations. While the SDQ1 and the Ross Test of Higher Cognitive Processes were administered by this researcher.

In order to get as complete a picture as possible as to what the instruction was typically like in both the Chapter 1 and HOTS classes the researcher conducted observations at each site on a random selection of classes. At least two classes per site were observed during the fall, winter, and the spring of the school year for a minimum of 42 observations. Also to get more information as to the effects of the HOTS program and the more traditional Chapter 1 classes, the researcher conducted open-ended interviews with randomly selected students and teachers across the research sites. There were at least two, half - hour interviews with each selected participant, one in the first quarter of the year and one in the last quarter of the year.

Design and Analyses. The present study utilized a pretest-posttest contrast group data collection design (Campell & Stanley, 1963).

Experimental group O_1 O_2 O_3 X_1 O_1 O_2 O_3 O_4

Control group O_1 O_2 O_3 X_2 O_1 O_2 O_3 O_4

Where O_1 = Iowa Test of Basic Skills

O_2 = Self Description Questionnaire 1

O_3 = Ross Test of Higher Cognitive Processes

O_4 = Interviews and Observations (continuous)

X_1 = Higher Order Thinking Skills Program

X_2 = Traditional Chapter 1 Program

Posttest scores were compared using a two-way analysis of covariance (ANCOVA). The posttest scores served as the dependent measures, and the pretest scores served as the covariates. The following three dependent variables were examined: self-concept, reading achievement, and higher order thinking skills. A separate ANCOVA was conducted on each of the dependent variables.

The multisite interviews and observations were analyzed using the analytic induction method of qualitative data analysis for triangulation data. This method was chosen because "analytic induction is employed when some specific problem, question, or issue becomes the focus of research. Data are collected and analyzed to develop a descriptive model that encompasses all cases of the phenomena" (Bogdan & Biklen, 1992, p. 70). This data was used to give a richer overall picture of the two programs. Selection from the interviews were used to help explain the quantitative findings.

Null Hypotheses

The following research hypotheses were studied in this investigation. Each hypothesis will be examined separately by grade.

Null hypothesis 1. There are no statistically significant posttest mean differences in the adjusted reported self-concept scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Null hypothesis 2. There are no statistically significant posttest mean differences in the adjusted reported reading achievement scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Null hypothesis 3. There are no statistically significant posttest mean differences in the adjusted reported higher order thinking skill - abstract relations scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Null hypothesis 4. There are no statistically significant posttest mean differences in the adjusted reported higher order thinking skill - sequential synthesis scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Null hypothesis 5. There are no statistically significant posttest mean differences in the adjusted reported higher order thinking skill -analysis of attributes scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Null hypothesis 6. There are no statistically significant posttest mean differences in the adjusted reported scores on each dependent measure between female and male students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Examination of Null Hypotheses

In order to examine the effects of a HOTS program on Chapter 1 eligible fourth and fifth grade students' self-concept, achievement, and higher order thinking skills, a pretest-posttest contrast group design was employed (Campbell & Stanley, 1963). Because randomization was not possible, the analysis of covariance procedure was used to adjust for initial group differences. A t-test on each of the dependent measures indicated significant preassessment differences on achievement and higher order thinking skill - abstract relations. Analysis of covariance procedures were also utilized to reduce error variance and increase statistical power. Hypotheses were tested using a priori alpha level of .05.

An assumption of the analysis of covariance is equality of regression slopes. A test for equality of slopes was therefore conducted for each of the three dependent measures at posttesting. Since the initial tests indicated that all of the regression slopes were equal at posttesting (all F values were nonsignificant), the analysis of covariance was then conducted to test each null hypothesis.

The results of the analyses and their relationship to each of the six null hypotheses follow. Each hypothesis will be addressed separately by grade. The students in both fourth grade groups had completed one year of the program and students in both fifth grade groups had completed two years of the program. Consequently, it was not possible to calculate overall changes.

Null Hypothesis 1. There are no statistically significant posttest mean differences in the adjusted reported self-concept scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

The obtained and adjusted means and standard deviations for both treatment groups for self-concept scores are summarized in Table 1. The table shows that fifth graders in the HOTS program had higher self-concept scores on the pretest than did fourth graders. This is due to the students being a year older and already having completed one year of the HOTS program. To investigate this hypothesis, a two-way analysis of covariance (ANCOVA) was performed to check for interactions between treatment condition and gender. No statistically significant interaction was found. The dependent measure was next analyzed without concern about potential sources of interactions. The ANCOVA results in table 2 were not significant for grade four but did indicate a statistically significant difference between fifth grade students in the HOTS programs and students in Chapter 1, $F(1, 83) = 3.46$, $p < .05$. The adjusted means, as shown in Table 1, show that the fifth grade students in the HOTS programs had significantly higher overall self-concepts ($M = 34.07$) than students in the Chapter 1 program ($M = 32.67$). Therefore, null hypothesis 1 was rejected.

Table 1

A Summary of Means and Standard Deviations for Self-Concept by Grade

	Pre Assessment		Post Assessment		Adjusted
	Means	SD	Means	SD	Means
HOTS					
Fourth Grade (n = 54)	31.54	5.66	32.43	5.59	32.70
Fifth Grade (n = 49)	33.00	5.49	34.24	3.97	34.07
Chapter 1					
Fourth Grade (n = 35)	32.38	3.74	31.74	3.77	31.47
Fifth Grade (n = 37)	32.30	4.17	32.50	4.42	32.67

Table 2

Analysis of Covariance for Students' Self-Concept by Grade Level

Source	df	SS	MS	F	p
Fourth Grade					
Treatment	1	32.01	32.01	2.22	0.14
Covariate	1	875.51	875.51	60.65	0.000*
Error	86	1241.47	14.44		
Fifth Grade					
Treatment	1	41.63	41.63	3.46	0.04*
Covariate	1	484.79	484.79	40.27	0.000*
Error	83	999.15	12.04		

*$p<.05$

Null Hypothesis 2. There are no statistically significant posttest mean differences in the adjusted reported reading achievement scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

The obtained and adjusted means and standard deviations for both treatment groups for reading achievement scores are summarized in Table 3. The table shows that fifth graders had higher reading achievement scores on the pretest than did fourth graders. This is due to the students being a year older and already having completed one year of the HOTS program. To investigate this question, a two-way ANCOVA was performed to check for interactions between treatment condition and gender. No statistically significant interaction was found. The dependent measure was next analyzed without concern about potential sources of interactions. The results from the ANCOVA are summarized in Table 4. The results indicate no statistically

Table 3

A Summary of Means and Standard Deviations for Reading Achievement by Grade

	Pre Assessment		Post Assessment		Adjusted
	Means	SD	Means	SD	Means
HOTS					
Fourth Grade (n = 54)	21.80	11.85	33.30	13.87	32.40
Fifth Grade (n = 49)	23.25	11.39	35.06	13.33	33.97
Chapter 1					
Fourth Grade (n = 35)	15.83	11.53	30.43	14.52	31.47
Fifth Grade (n = 37)	16.03	11.44	29.46	11.02	32.67

significant difference in fourth or fifth grade between students in the HOTS programs and students in Chapter 1, Fourth Grade, $F(1, 86) = 0.13$; Fifth Grade, $F(1, 83) = 1.55$, $p > .05$. The adjusted means, as shown in Table 3, indicate that the students in the HOTS programs had scores

that were not significantly higher on the ITBS (Fourth Grade, M = 32.40; Fifth Grade, M = 33.97) as compared with students in the Chapter 1 program (Fourth Grade, M = 31.47; Fifth Grade, M = 32.67). Therefore, null hypothesis 2 was accepted.

Table 4

Analysis of Covariance for Students' Reading Achievement by Grade

Source	df	SS	MS	F	p
Fourth Grade					
Treatment	1	23.76	23.76	0.13	0.72
Covariate	1	1212.15	1212.15	6.39	0.01*
Error	86	16302.57	189.57		
Fifth Grade					
Treatment	1	222.77	222.77	1.55	0.22
Covariate	1	1447.15	1447.15	10.09	0.00*
Error	83	11899.62	143.37		

*$p<.05$

Null Hypothesis 3. There are no statistically significant posttest mean differences in the adjusted reported higher order thinking skill - abstract relations scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

The obtained and adjusted means and standard deviations for both treatment groups for achievement scores are summarized in Table 5. The table shows that fifth graders had higher achievement scores on the pretest than did fourth graders. This is due to the students being a year older and already having completed one year of the HOTS program. To investigate this hypothesis, a two-way ANCOVA was performed to check for interactions between treatment condition and gender. No statistically significant interaction was found. The dependent measure was next analyzed without concern about potential sources of interactions. The ANCOVA

Table 5

A Summary of Means and Standard Deviations for Higher Order Thinking Skill - Abstract Relations by Grade

	Pre Assessment		Post Assessment		Adjusted
	Means	SD	Means	SD	Means
HOTS					
Fourth Grade (n = 54)	3.57	2.54	3.72	2.41	3.85
Fifth Grade (n = 49)	5.39	2.69	5.49	2.97	5.75
Chapter 1					
Fourth Grade (n = 35)	4.37	3.07	3.31	2.35	3.19
Fifth Grade (n = 37)	6.89	3.57	5.70	3.52	5.44

results shown in table 6 indicate no statistically significant difference between students in HOTS programs and students in Chapter 1, Fourth Grade, $F(1, 86) = 1.84$; Fifth Grade, $F(1, 83) = 0.20$, $p > .05$. The adjusted means, as shown in Table 5, indicate that the students in the HOTS programs had scores that were not significantly higher on abstract relations (Fourth Grade, M = 3.85; Fifth Grade, M = 5.75) as compared with students in the Chapter 1 program (Fourth Grade, M = 3.19; Fifth Grade, M = 5.44, SD = 3.52). Therefore, null hypothesis 3 was accepted.

Null Hypothesis 4. There are no statistically significant posttest mean differences in the adjusted reported higher order thinking skill - sequential synthesis scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

The obtained and adjusted means and standard deviations for both treatment groups for achievement scores are summarized in Table 7. The table shows that fifth graders had higher achievement scores on the pretest than did fourth graders. This is due to the students being a year older and already having completed one year of the HOTS program. To investigate this

Table 6

Analysis of Covariance for Students' Higher Order Thinking Skill - Abstract Relations by Grade

Source	df	SS	MS	F	p
Fourth Grade					
Treatment	1	9.18	9.18	1.84	0.18
Covariate	1	62.65	62.65	12.59	0.00*
Error	86	428.08	4.98		
Fifth Grade					
Treatment	1	1.84	1.84	0.20	0.66
Covariate	1	94.07	94.07	10.08	0.00*
Error	83	775.02	9.34		

*$p < .05$

hypothesis, a two-way ANCOVA was performed to check for interactions between treatment condition and gender. No statistically significant interaction was found. The dependent measure was next analyzed without concern about potential sources of interactions. The results of the ANCOVA by grade in table 8 were not significant for fourth graders. However, a statistically

Table 7

A Summary of Means and Standard Deviations for Higher Order Thinking Skill - Sequential Synthesis by Grade

	Pre Assessment		Post Assessment		Adjusted
	Means	SD	Means	SD	Means
HOTS					
Fourth Grade (n = 54)	0.83	0.95	1.11	1.18	1.11
Fifth Grade (n = 49)	1.12	1.09	1.78	1.19	1.78
Chapter 1					
Fourth Grade (n = 35)	0.77	0.88	0.74	0.85	0.74
Fifth Grade (n = 37)	0.97	1.14	0.97	1.01	0.97

significant difference in fifth grade between students in the Higher Order Thinking Skills (HOTS) programs and students in Chapter 1, $F(1, 83) = 10.52$, $p < .05$ was found. The obtained adjusted means, as shown in Table 7, indicates that the fifth grade students in the HOTS programs had significantly higher overall sequential synthesis scores ($M = 1.78$) as compared with students in the Chapter 1 program ($M = 0.97$). Therefore, null hypothesis 4 was rejected.

Table 8

Analysis of Covariance for Students' Higher Order Thinking Skill - Sequential Synthesis by Grade

Source	df	SS	MS	F	p
Fourth Grade					
Treatment	1	3.00	3.00	2.66	0.11
Covariate	1	1.11	1.11	0.99	0.32
Error	86	96.91	1.13		
Fifth Grade					
Treatment	1	13.36	13.36	10.52	0.00*
Covariate	1	0.11	0.11	0.08	0.77
Error	83	105.40	1.27		

*$p<.05$

Null Hypothesis 5. There are no statistically significant posttest mean differences in the adjusted reported higher order thinking skill -analysis of attributes scores of students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

The obtained and adjusted means and standard deviations for both treatment groups for higher order thinking skill - analysis of attributes scores are summarized in Table 9. The pretest means are higher for fifth graders in the HOTS program, reflecting one more year of treatment and a year older. To investigate this hypothesis, a two-way ANCOVA was performed to check for interactions between treatment condition and gender. No statistically significant interaction was found. The dependent measure was next analyzed without concern about potential sources of interactions.

Table 9

A Summary of Means and Standard Deviations for Higher Order Thinking Skill - Analysis of Attributes by Grade

	Pre Assessment		Post Assessment		Adjusted
	Means	SD	Means	SD	Means
HOTS					
Fourth Grade (n = 54)	7.50	2.30	7.46	1.94	7.48
Fifth Grade (n = 49)	7.88	2.98	8.45	1.86	8.44
Chapter 1					
Fourth Grade (n = 35)	7.94	1.59	7.43	1.75	7.41
Fifth Grade (n = 37)	7.59	1.61	7.46	1.98	7.47

The results of the ANCOVA by grade were not significant for fourth graders, but were significant for fifth grade students, $F(1, 83) = 5.34$, $p < .05$. The adjusted means in Table 9 indicate that the fifth grade students in the HOTS program had significantly higher scores for sequential synthesis (M = 8.44) as compared with fifth grade students in the Chapter 1 program (M = 7.47). Therefore, null hypothesis 5 was rejected. The results from the ANCOVA are summarized in Table 10.

Null Hypothesis 6. There are no statistically significant posttest mean differences in the adjusted scores on each dependent measure between female and male students receiving the Higher Order Thinking Skills program and subjects receiving Chapter 1 services.

Readers should remember that to investigate this question, two-way ANCOVA were performed on each dependent measure to check for interactions between treatment condition and gender. No statistically significant interaction were found. The dependent measures were next

Table 10

Analysis of Covariance for Students' Higher Order Thinking Skill - Analysis of Attributes by Grade

Source	df	SS	MS	F	p
Fourth Grade					
Treatment	1	0.08	0.08	0.02	0.88
Covariate	1	1.49	1.49	0.42	0.52
Error	86	302.51	3.52		
Fifth Grade					
Treatment	1	19.45	19.45	5.34	0.02*
Covariate	1	4.92	4.92	1.35	0.25
Error	83	302.39	3.64		

*$p<.05$

analyzed without concern about potential sources of interactions. There were no statistically significant differences found between male and female scores on the dependent measures of self-concept, achievement, and higher order thinking skills - sequential synthesis and analysis of attributes. However, there was statistical significance found, for fifth graders in the HOTS program, in higher order thinking skill - abstract relations, $F(1, 46) = 8.90$, $p < .05$ as shown in table12. The means, as shown in Table 11, indicate that fifth grade female students in the HOTS program had significantly higher scores as compared with fifth grade male students in the HOTS program. Therefore, null hypothesis 6 was rejected.

Table 11

A Summary of Means for Higher Order Thinking Skill - Abstract Relations by Gender

	Pre Assessment		Post Assessment		Adjusted
	Means	SD	Means	SD	Means
HOTS					
Fourth Grade (n = 54)					
Male (n = 27)	3.26	2.77	3.19	2.24	3.28
Female (n = 27)	3.89	2.29	4.26	2.51	4.16
Fifth Grade (n = 49)					
Male (n = 23)	6.09	2.47	4.43	2.63	4.23
Female (n = 26)	4.77	2.78	6.42	3.00	6.63
Chapter 1					
Fourth Grade (n = 35)					
Male (n = 16)	2.88	3.12	2.81	2.26	3.22
Female (n = 19)	5.63	2.45	3.74	2.40	3.33
Fifth Grade (n = 37)					
Male (n = 17)	6.12	3.74	4.88	3.28	5.18
Female (n = 20)	7.55	3.36	6.40	3.65	6.10

Table 12

Analysis of Covariance for Students' Higher Order Thinking Skill - Abstract Relations for Students in the HOTS Program by Gender

Source	df	SS	MS	F	p
Fourth Grade					
Gender	1	10.21	10.21	2.00	0.16
Covariate	1	38.50	38.50	7.55	0.00*
Error	51	260.13	5.10		
Fifth Grade					
Gender	1	66.38	66.38	8.90	0.01*
Covariate	1	32.92	32.92	4.41	0.04*
Error	46	343.08	7.46		

*p<.05

Discussion of the Results

Results of the study for each of the dependent variables are discussed in the following sections. Analyses were conducted separately by grade level.

Self-Concept. For null hypothesis one the effect of training on students' self-concept as measured by the Self-Descriptive Questionnaire 1 was examined. An analysis of covariace was utilized to test the null hypothesis with individual pretest scores serving as the covariate. The results indicated that there was a statistically significant difference in the self-concept of fifth grade students in the two treatments. Fifth grade students in the Higher Order Thinking Skills program had significantly higher self-concepts after treatment than did students in the Chapter 1 program. There was no significant difference between the treatment groups on self-concept scores at the fourth grade, however. No significant interactions were found between the treatment received and whether the student was male or female.

One possible explanation for the positive finding in fifth grade could be the effect of working daily with computers. Interviews with students from both treatment groups indicated that students viewed computers as activities for "smart" students. A common response to questions about who gets to work on computers was "Only kids that go to Spectrum (gifted classes) get to work on computers" or "We get to work on computers one time a week. They (spectrum students) work on them (computers) every day." Students in the HOTS program made statements about how they felt on "Visitation days" when they got to bring someone to HOTS to show what they could do on the computers; "They think we are real smart 'cause they can't do the computers like we can" ; "My mom came and she was surprised that I could do better than her on the computer." and "I beat my teacher on Carman Sandiago." Working daily with the computers may help to raise students' self-concept.

Students perceptions of how their peers and parents view the two treatment programs may have influenced the rise in students' self-concepts. Students in the Chapter 1 program made statements about how others think about Chapter 1 such as "They know we do work that little kids do" ; "Mom said if I learn to read good I don't have to go to that class (Chapter1) any more"; "My friends say I go to the dumb class" ; and "Nobody wants to go to Mrs _____ class. We do baby things." At the same time the Higher Order Thinking Skills program seems to be viewed more positively; "_____ and _____ (students friends) keep asking when they get to go to HOTS" ; "Everyone keeps on saying why do we get to do all that fun stuff in HOTS" ; and "They (classmates) always want me to help them when we go to computer lab because I work with the computers all the time." Peers and parents views of the programs may have an influence on students' self-concept.

Another possible explanation for this finding could be the program itself. Students' higher self-concept may stem from different teaching methods in the Higher Order Thinking Skills program. Teaching techniques such as "controlled floundering" force students to work through difficult problems on their own. Students are allowed to initially fail at an activity then given the time and encouragement needed to work through to a successful solution. Students in the HOTS

program talked in interviews about having to work through problems on their own and the lack of "help" from the HOTS teacher. Students made statements such as "She (the teacher) won't help you" ; "The teacher just says you can do it and everything you need to solve the problem is on the screen." Stopping teachers from giving unnecessary help when students encounter difficulties is part of the training for HOTS teachers. According to interviews with the teachers, "It is hard to let students get frustrated and not help them, but when all the information is on the screen they seem to learn better when they work it out themselves." The differences in treatment may contribute to this finding.

The lack of any significant difference in fourth grade may be due to a lack of time in the HOTS treatment group. The HOTS developers suggest it may take more than one year to find positive results from the program and this finding seems to support this claim. The absents of significant difference between males and females may be due to the age of the students. Differences in self-concepts between males and females may not manifest themselves until later in adolescents.

Reading Achievement. There was no statistically significant difference found in grade four or five between the adjusted post treatment means for reading achievement. There was also no statistically significant difference found between male and female adjusted post treatment means for reading achievement. On the average both treatment programs were effective in raising the participants achievement scores. The average score for a student in the Higher Order Thinking Skills programs was raised 11.50 NCEs in fourth grade and 11.82 NCEs in fifth grade. While the average score for a student in the Chapter 1 program was raised 14.60 NCEs in fourth grade and 13.43 in fifth grade.

One possible explanation may be that the increase in skills learned in the HOTS program have not had enough time to transfer to an increase in reading achievement on standardized test. The students may need more time in the program or more coordination between the Higher Order Thinking Skills program and the regular classroom.

Both teachers and students in the HOTS program talked about the need for regular classroom teachers to use strategies employed in the program. HOTS teachers made statements such as "We need to provide their regular teachers some training like we got so that they can use the same strategies in the kid's rooms" ; "I think the students need this type of teaching all day long. The way we question students and have them work through problems really helps them." Students also talked about the questioning or probing HOTS teachers do in class. "She (HOTS teacher) asks us questions about the word and we have to figure out the word. She will like...she can't give us clues so she just stays on us and stays on us. That is what is called probing. She don't go on to the next person right away"; "When you're being probed it seems like you're never going to get the answer. Why is she doing this to me? And then when you get it you get so excited"; "When you get the answer everyone claps for you"; "I try not to give up and she tells us that we can not give up and we have to do it." When asked, HOTS students said they wished their classroom teacher would ask questions the way their HOTS teacher did. "If you don't know the answer in Mrs._____ class (the regular classroom teacher) she calls on someone else or tells you" ; "In my class I just sit there 'cause the teacher will go on (to another student)"; "In class (the regular classroom) I feel like I don't know the word because my teacher just told me the answer and I don't know nothing about the word." It is possible that the use of the HOTS strategies in the regular classroom would help to facilitate the transfer of skills.

Higher Order Thinking Skills - Abstract Relations. There was no statistically significant difference found in fourth or fifth grade between the adjusted post treatment means for abstract relations. Students in the Chapter 1 program on the average actually received lower scores on the posttest than on the pretest. This regression could be due to the Chapter 1 programs concentration on basic skills. Students may become so used to short easy answers that they fail to try on harder problems, spend less time working for an answer, and resort to guessing more often. This could result in a reduction in the average score on higher order thinking skills.

One possible explanation for the lack of significant gains in this higher order thinking skill may be that the two programs might raise some skills but not others. There is a great debate over

what are higher order thinking skills, how are they organized, and how best to teach students to use these skills. It is very possible that it requires many types of instruction in many ways in order to teach a variety of thinking skills, and that these two programs are not the ideal way to provide instruction for this particular thinking skill.

There were, however, statistically significant differences found for abstract relations between males and females in the HOTS program. Fifth grade female students in the HOTS program had statistically higher scores than fifth grade males in the HOTS program. This finding is supported by student interviews. Female students, on average, were able to express what they had learned in the program better than male students. One possible explanation could be that, developmentally, female students in the fourth and fifth grade may be more effected by the HOTS program.

Sequential Synthesis. The results of this study indicated a statistically significant difference in the higher order thinking skill of sequential synthesis of the students in fifth grade in the two treatments. Fifth grade students in the HOTS program had significantly higher scores on sequential synthesis than fifth grade students in Chapter 1. There was no significant difference found between the treatment groups at the fourth grade or between males and females. It is possible that the HOTS program does a better job raising student sequential synthesis skills, but it takes more than one year for the difference to manifest itself. This finding would support the claims by the HOTS promoters that it takes two years of training in the program for results to be seen.

Analysis of Attributes. The results of this study indicated a statistically significant difference in the higher order thinking skill - analysis of attributes of fifth grade students in the two treatment groups. Fifth grade students in the HOTS program had significantly higher scores on the higher order thinking skill - analysis of attributes than fifth grade students in Chapter 1. There was no significant difference between the treatment groups at the fourth grade or between males and females.

This seems to be a skill the HOTS program is successful in raising. The programs effects for analysis of attributes are greater after two years of the treatment supporting the need for two years of participation in the program. The results of the interviews with students do not give much insight into research hypotheses three, four, or five. The interviews indicate that students are not aware of what skills they are working on in the Higher Order Thinking Skills program. When asked what they were learning students responses generally included references to strategies. The students were able to give examples of strategies they used with the computer software, but were unable to generalize to the regular classroom. These findings from the interviews are in line with the HOTS program's beliefs about not teaching the thinking skills directly to students, but may indicate a need for more coordination between the regular classroom and the HOTS program.

Summary

These finding suggest that the Higher Order Thinking Skills program is effective in raising students' self-concepts and some higher order thinking skills in the fifth grade. The findings suggests that the program is more effective after two years of treatment, and that females in grade 5 are effected more than males. Both the HOTS program and the Chapter 1 program raised students achievement scores. However, this study failed to find any statistically significant difference in achievement of students in the HOTS program as compared to students in Chapter 1 programs. It is not certain what other thinking skills the HOTS program might affect or if these students' achievement scores will go up later as a result of this treatment. This study's findings also suggest that females in these grades may be developmentally more ready for this treatment than males.

These results, along with the interviews and observations, indicate that there needs to be more coordination between the HOTS program and the regular classroom. Classroom teachers need to be trained to use the questioning and probing techniques used in the HOTS program and provide more tie in between the HOTS strategies and the regular classroom. Students stated that even though they did not like it when they were being questioned or when they were struggling to

work out an answer to a difficult problem, they felt better about themselves and felt they learned more than they did in the regular classroom.

Is the HOTS program effective enough to warrant the expense? If schools are interested in raising students' self-concepts, this program seems to be effective, but more research is needed before the program can be evaluated for its ability to raise achievement and higher order thinking skills.

Recommendations for Future Research

The results of this study suggest many directions for future research. Some questions which might be answered by future research include the following:

1. What other types of higher order thinking skills does the HOTS program raise?

2. Would students' achievement scores increase significantly if the treatment were begun earlier and continued for more years.

3. Would training regular classroom teachers in HOTS techniques help to raise students' achievement scores?

4. Would more coordination between the HOTS program and the regular classroom raise students' scores?

5. Would training Chapter 1 teachers to use HOTS techniques raise Chapter 1 students' scores?

6. Would the HOTS program be effective without the use of computers?

7. Would the gap between male and female students be closed by using the HOTS program in later grades?

8. Would different measuring tools result in similar findings?

Additional research should be conducted to determine if the Higher Order Thinking Skills program is effective. If so, what parts of the program work and how can they be adapted to be most effective. If schools are to make informed decisions about how best to help their students, educational programs must be evaluated to determine their merit. More research is needed before conclusions can be drawn on the Higher Order Thinking Skills program.

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